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Toxic Contaminants in the Great Lakes

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The states in the region served by the three organizations are Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, and Wisconsin.

Cover map, showing U.S. and Canadian "areas of concern," courtesy of the International Joint Commission.

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Summary

In the summer of 1985, the National Research Council of the U.S. National Academy of Sciences and the Royal Society of Canada released a report on the water quality of the Great Lakes. Among its findings, the report reached the ominous conclusion that the population of the Great Lakes basin was exposed to more toxic substances than the U.S. population as a whole, due in part to the consumption of contaminated fish from toxic-infested waters. (Studies in Wisconsin have documented the lower growth rate of infants whose mothers' milk was poisoned as a result of eating fish contaminated with PCBs.)

The NRC/RSC report did not surprise those researchers who have documented the buildup of synthetic chemical compounds and toxic metals that have accumulated in the lakes (even in the deceptively clear waters of Lake Superior). It is only in the last decade, however, that scientists have begun to identify with increasing certainty the complex sources of this pollution.

The most familiar culprits are the factories that discharge waste-waters directly into the basin, a practice that is as old as the industrial settlements surrounding the lakes. Here, the Environmental Protection Agency can claim significant progress: regulations under the Clean Water Act gradually have tightened discharge permits for many industries, at least for the "priority" toxic pollutants. With the possible exception of the organic chemical industry, these regulations will be achieved at minimal cost.

In contrast, little progress has been made in stopping the flow of toxics into the lakes from other sources, such as:

- air emissions that are the primary source of heavy metals in the upper Great Lakes;
- runoff from city streets and farmlands;
- leaking landfills, which in the Niagra area alone release 1,500 pounds of chemicals daily into Lake Ontario; and
- toxic sediments that infest river bottoms and harbors in at least 43 locations across the lakes.

The solution, embodied in the U.S.-Canada Great Lakes Water Quality Agreement, is to develop a comprehensive toxics management strategy that reduces contaminants flowing into the lakes from all sources. The Clean

Preface

The history of the Great Lakes region is one of struggle to balance the needs of a dynamic, highly industrialized society with those of its natural environment. Toxic pollution today threatens to tip that balance by slowly poisoning the world's largest supply of surface freshwater. Activities to preserve this natural resource have evolved from relatively simple early programs to upgrade sewage treatment plants, to more complex efforts to contain the enormous flow of toxic contaminants entering the watershed every day.

This report results from a binational conference held in Toronto and Mackinac Island in June 1985, at which members of Congress and the Canadian Parliament were briefed by experts from both sides of the border on toxic contamination problems in the Great Lakes. It reviews the extent of contamination and how current federal programs are designed to solve the problem. After examining numerous sources of contamination, the report considers the ecosystem-based approach to pollution control: a coordinated regulation of pollutants from all sources. Endorsed by the U.S.-Canada International Joint Commission, the Royal Society of Canada, and the U.S. National Academy of Sciences, this effort holds real promise as a long-term solution.

The report also discusses a new congressional initiative, the Kasten-Nowak amendment to the Clean Water Act, which would provide EPA with the resources and management structure to carry out a comprehensive toxic cleanup strategy. The report concludes with a brief review of issues needing resolution before the most complex phase in the cleanup of the lakes can be successful.

Water Act, reauthorized by Congress last year, includes an amendment that required EPA to design and carry out an integrated toxics control strategy mandated by the Water Quality Agreement. The amendment is an important first step in bringing order to the haphazard federal policy toward the Great Lakes, and to respond to criticism of lack of a coordinated management plan voiced by the U.S. General Accounting Office, the International Joint Commission, and the National Academy of Sciences. While the president vetoed the Clean Water bill on November 6, 1986, Congress is expected to pass the bill in the same form in the first weeks of the 100th Congress, and to override a second veto if necessary.

The amendment is only a beginning, however. Other actions that should be taken include establishing a system of permit fees for industries that discharge wastes into the basin to pay for establishment of a sophisticated toxics monitoring network; controlling hazardous air pollutants through the Clean Air Act; and gaining access to Superfund grants for the cleanup of contaminated sediments. In the last analysis, a major reduction in the sheer volume of hazardous waste generated by the industrial activity in the Great Lakes basin is the only sure way to protect the water quality of the Lakes.

Dimensions and Sources of Toxic Contamination

On June 7-8, 1985, several members of the Canadian Parliament and the U.S. Congress met in Toronto and on Mackinac Island to consider how to confront the continuing threat of toxic pollution in the Great Lakes. The forum was supported by a grant from the Charles Stewart Mott Foundation and sponsored by the Northeast-Midwest Institute, the Northeast-Midwest Congressional and Senate Coalitions, the Center for the Great Lakes, and the Canadian Centre for Legislative Exchange. Representing the United States at the conference were U.S. Senator Robert Kasten (R-WI) and U.S. Representatives Henry Nowak (D-NY), George O'Brien (R-IL), Robert Traxler (D-MI), Carl Pursell (R-MI), and Dennis Eckart (D-OH). The delegations heard reports from Canadian and U.S. environmental program managers and reviewed progress toward meeting the goals of the Canada-U.S. Great Lakes Water Quality Agreement, which provides an international framework for the elimination of toxic pollutants.

The conference raised several questions that must be answered satisfactorily in the next few years.

- What are the dimensions and sources of the toxic pollution problem in the Great Lakes?
- How effective are current U.S. programs under the Clean Water Act in remedying toxic pollution in the lakes?
- Can the U.S. improve its management of Great Lakes environmental programs to produce a comprehensive "ecosystem" approach to the reduction of toxic pollution in the Great Lakes basin?
- How would the Kasten-Nowak amendment to the Clean Water Act provide a more effective means to that end?
- How do limitations on U.S. federal funds affect Great Lakes environmental management?

A New Kind of Pollution

By the 1960s the unguided development of cities and factories along their shores threatened to overwhelm the lower lakes. Lake Erie provided the most dramatic example. Heavy loads of phosphates from untreated sewage gradually had sucked the oxygen out of the water, leaving behind floating mats of algae and dead fish. Scientists were almost ready to declare Lake Erie biologically dead when Congress was galvanized into enacting the Federal Water Pollution Control Act in 1972. It was the beginning of a new effort to control "conventional" pollutants (like phosphorus) through grants to upgrade city sewers and permits regulating discharges of waste by industries.

Together, the U.S. and Canada have invested more than $8.2 billion in municipal wastewater treatment plants in the Great Lakes basin. Elimination of millions of tons of sewage has allowed the waters to breathe again. Lake Erie shows the most striking gains; sport fishermen once again are angling for perch and walleye.

As the algae blooms gave way to a more diversified aquatic life, however, some of the newly caught fish showed evidence of a more insidious problem: toxic pollution. Sixteen percent of the drum caught at one Lake Erie site showed signs of skin cancer. This time, however, Lake Erie does not hold first place as the the worst polluted of the Great Lakes. That dubious distinction belongs to Lake Ontario, which receives nearly 3,000 pounds of chemicals every day from its main tributary, the Niagara River.

However, all of the lakes are threatened. Scientists have found over 800 chemical compounds in the western Great Lakes, and more are discovered every month. Unlike the more conventional pollutants, such as phosphates, the damage from toxic pollution appears in the most remote reaches of the lakes. For example, PCBs have been discovered in herring gull eggs on Isle Royale in the middle of Lake Superior, far from industrial or municipal discharges.

Great Lakes: The Resource

A few statistics help to outline the vast dimensions of the Great Lakes, as well as underscore their importance as an economic and environmental resource. The lakes hold an incredible 95 percent of U.S. surface freshwater, enough to cover all states to a depth of 12 feet. Over 24 million people draw their drinking water supply every year from this inland ocean. Farmers draw 226 million gallons for irrigation; industries draw 13 billion gallons annually for manufacturing; and power plants draw 23 billion gallons to generate electricity. In his welcoming address at the Mackinac Island forum, William B. Milliken, former governor of Michigan, reminded the audience that the natural beauty of the lakes has tangible economic value, generating over $8 billion annually in income from recreational activities alone.

The Great Lakes basin is home to 28 million Americans and 7 million Canadians. Notwithstanding the deep recession from which the Midwest is now recovering, the Great Lakes are surrounded by one of the greatest industrial centers in the world. Their waters drive the turbines of 64 power plants; their shores boast 119 harbors that provide a base for the region's shipping industry. According to a survey by the Federal Reserve Bank of Chicago and the Great Lakes Commission, the eight Great Lakes states produced 42 percent of the value of U.S. manufacturing in 1982. These states account for an even greater percentage of the value of several key industrial sectors. For example, the Great Lakes states accounted for:

- 69.6 percent of the nation's steel production in 1984;
- 72 percent of the value of the metal-cutting industry in 1982;
- 65.7 percent of the value of metal-working machinery in 1982; and

- 68.1 percent of the value of motor vehicle production in 1982 (at the Mackinac Island conference, Nicholas Kachman of General Motors pointed out that 128 of his company's 171 plants were located in the U.S.-Canadian Great Lakes basin).

Table 1 provides a state-by-state comparison of selected key sectors.

Toxic Wastes in the Lakes

As industry developed around the Great Lakes basin, many unwanted by-products of manufacturing were produced. In keeping with the practices at the time, huge amounts of wastes, many containing toxic elements, were discharged into the waters feeding the lakes, and directly into the lakes themselves. At the time, the oceanic size of the Great Lakes seemed more than adequate to absorb or break down these toxic materials. This assumption has proven false for three major reasons.

First, water leaves the Great Lakes through the St. Lawrence River at a rate of only one percent of total volume per year. This slow flushing rate makes the Great Lakes more like a sink for toxic chemicals than a sieve through which impurities filter out gradually. Second, many toxic chemicals do not degrade naturally in the environment and some will take hundreds of years to work their way out of the Great Lakes basin. Toxic wastes also accumulate in lake bottom sediments where they may lie until disturbed by storms or harbor-dredging. These contaminated sediments are resistant to even the minimal flushing rate that characterizes the Great Lakes system. Finally, toxic chemicals may pose their greatest danger in synergistic effects that occur when substances in different wastes combine. The effects of these new compounds on human health and the environment are unknown and potentially most damaging. As John Leatherland of the University of Guelph points out, "we are finding the dangers of mixed (chemical) cocktails to be far more serious than single chemicals."

Location of Contamination

Toxic contaminants are characteristic of all five Great Lakes. As mentioned previously, PCBs lie in the deep waters of Lake Superior, hundreds of miles from human activity, apparently carried through the atmosphere by wind and rain. A 1985 study by the Environmental Fund, which rated the Great Lakes according to the degree of toxic contamination, found Lake Ontario in the worst condition. It reported that "the levels of persistent organochlorine compounds are higher in Lake Ontario than in any other of the Lakes." The report cited Lake Michigan as the next worst, with its fish containing higher levels of DDT and PCBs than others. Lake Erie placed in the middle. Lake Huron -- cited as the "second cleanest" -- also hosts herring gull colonies with dioxin levels six times higher than those in other lakes. While the report rated Lake Superior as the best, it warned that "many persistent complex organic compounds are found in its clear blue waters -- including DDT, PCBs, and toxaphenes." Table 2 provides a list of toxic compounds characteristic of the Great Lakes, their locations, and their likely effects on human health.

Table 1
Production and Added Value of Great Lakes Industries

Region & State	Value Added Motor Vehicles: 1982 (in millions of dollars)	Production of Raw Raw Steel: 1984 (thousands of net tons)	Value Added in the Metalworking Machinery Industry: 1982 (in millions of dollars)	Value Added in the Machine Tools Industry: 1982 (in millions of dollars)	Pulp and Paper Industry 1982 Employment (thousands)	Petrochemical and Petrochemical Products 1981 Value Added (in millions of dollars)
Illinois	806.3	6,504	1,108.3	562.7	33.0	91,900
Indiana	1,844.4	19,793	314.2	221.9	11.0	46,900
Michigan	12,701.2	7,754	2,223.2	1,550.6	20.1	89,500
Minnesota	407.6	N/A	160.2	111.4	12.8	34,200
New York	756.8	515	607.8	324.8	43.2	127,900
Ohio	4,539.6	15,348	7,766.8	1,035.0	31.9	86,400
Pennsylvania	866.6	14,372	711.7	386.7	38.0	71,000
Wisconsin	1,438.4	0	542.1	381.8	41.7	26,300
Great Lakes Region Total	23,360.9	64,376	7,434.3	4,574.9	232.7	574,100
U.S. Total	34,293.5	92,528	11,322.7	3,335.0	608.0	1,684,900
Percent of U.S. Total	68.1	69.6	65.7	72.0	38.0	34.0

SOURCE: Federal Reserve Bank of Chicago and the Great Lakes Commission, The Great Lakes Economy: A Resource and Industry Profile of the Great Lakes States (Boyne City, Michigan, Harbor House Publishers, 1985), pp. 91, 93, 95, 97, 99.

Table 2

Toxic Chemicals Found in the Great Lakes

Name	Use	Probable Source	Found In	Characteristics/ Health Effects
Chlorinated Organics	Wide variety of industrial uses.	Industrial discharges, agricultural runoff, chlorination of wastewaters.	Lakes Michigan, Huron, Erie	Bioaccumulation in fish, wildlife, humans. Suspected cause of cancer in humans when found in drinking water.
DDT, chlordane, dieldrin, aldrin	Pesticides used widely in Great Lakes region to control insects, rodents. DDT banned in 1971; others now restricted.	Residues from previous widespread use; runoff from agricultural and forested areas, leaching from improper waste disposal sites.	All five Great Lakes	Bioaccumulation in fish, wildlife, humans. Persistent in the environment. Long-range effects can include reproductive disorders in wildlife. Suspected cause of cancer in humans.
HCB (hexachlorobenzene) HCBD (hexachlorobutadiene)	Pesticides, wood preservatives, fungicides; by-products of chloralkali industry; used in production of synthetic rubber.	Industrial discharges, agricultural runoff, disposal of waste products.	Lake Erie, Lake Michigan	Bioaccumulation in fish, wildlife, humans. May produce skin rash, headache, nausea. Suspected cause of cancer.
Heavy metals (mercury, lead, arsenic, cadmium, copper, chromium, brass, selenium, zinc)	Wide variety of industrial uses, from anti-knock agent in gasoline to paints, pipes, pesticides, glass, and electroplating.	Industrial discharges, medical profession wastes via municipal discharges, agricultural runoff, dispersal of waste products, mine tailings.	All five Great Lakes	Excessive levels of heavy metals bioaccumulate in fish and wildlife. Human consumption of such contaminated food may cause a variety of health problems. Mercury can cause brain damage, birth defects. Lead: anemia, fatigue, irreversible brain damage, especially in children. Cadmium: kidney damage, metabolic disturbances. Arsenic: damage to liver, kidney, digestive system, bone marrow, suspected cause of cancer in humans. Copper, chronium, iron, selenium, and zinc are toxic to fish.
Mirex	Insecticide used to control fire ants; flame retardant; plasticizer.	Was produced, processed in Great Lakes until ban in 1975; spills.	Buffalo, Niagara Rivers; Lake Ontario	Bioaccumulation in fish, wildlife, humans. Persistent in the environment. Suspected cause of cancer in humans.
PAHs (polyaromatic hydrocarbons)	Variety of industrial uses.	Industrial oil and grease discharges; by-product of all types of combustion.	All five Great Lakes	Persistent in the environment. Induces cancer and causes chromosome damage in fish, wildlife and humans.
PBBs (polybrominated biphenyls)	Fire retardant.	Industrial discharges.	Lake Huron	Bioaccumulation in fish, wildlife, humans. Cause of birth defects and possibly cancer in laboratory animals.
PCBs (polychlorinated biphenyls)	Insulation for electrical capacitors, transformers; plasticizer; wide industrial usage. Total ban except by special EPA permit in July, 1979.	Industrial discharges, municipal sewage treatment plant discharges, harbor sediments, low temperature incineration of wastes.	All five Great Lakes	Bioaccumulation in fish, wildlife, humans. Persistent in the environment. Test monkeys developed reproductive failures, skin and gastrointestinal disorders.

Source: Environmental Protection Agency, 1980. "Toxic Substances in the Great Lakes." EPA 905/9-80-005

While some toxics are found in deep water, most are concentrated in shore areas near major industrial centers. The International Joint Commission (IJC) has characterized 42 of these locations as "areas of concern" requiring special remedial action to meet the goals of the Canada-U.S. Great Lakes Water Quality Agreement. The IJC is a binational organization that monitors the progress of both countries toward meeting the goals of the agreement. The map (Figure 1) shows the location of the 42 areas of concern.

Contaminated sediments characterize 37 of these sites, while toxic organics are found at 31 sites and heavy metals at 29. Twenty-five sites are wholly within the United States, 12 are in Canada (all in Ontario), and five are shared between U.S. and Canadian jurisdictions at rivers that connect the Great Lakes. Only one site, Lake Muskegon in Michigan, has been cleaned up.

Effects on Humans and Fish

The fish of the Great Lakes, particularly larger species with a higher percentage of body fat, store up absorbed toxic compounds, a process known as bioaccumulation. Scientists have recorded no fewer than 167 chemical compounds in the flesh of trout taken from Lake Michigan. While the tendency of fish to bioaccumulate toxins makes them ideal subjects for studying the impact of chemicals on the Great Lakes ecosystem, it makes many species -- particularly those most popular with sport fishermen -- dangerous to eat. Jane Elder and Marge Renald Wetzel, in a 1985 article in Sierra magazine, cited a study estimating that "a human being would have to drink Great Lakes water for a thousand years in order to consume the amount of PCBs in a one pound serving of fish. . . ." At the Mackinac Island conference, David Walsh of the U.S. Fish and Wildlife Service's Great Lakes Fisheries Laboratory shocked members of Parliament and Congress with color slides of the lip tumors and skin cancers found on the popular gamefish of the Great Lakes.

More disturbing than the unsightly effects these potent carcinogens produce on aquatic life is the threat to humans who eat Great Lakes fish. A study of infants breast-fed by mothers consuming PCB-laden fish found that the children had smaller heads at birth, and appeared to develop more slowly than children of mothers not exposed to that toxic chemical. The health effects of most of the chemical compounds found in the lakes are unknown, because many of the substances have been discovered in the last several years and population studies are very expensive and time-consuming. Nevertheless, a 1985 joint report by the the National Research Council (NRC) of the National Academy of Sciences and the Royal Society of Canada (RSC) warns that:

> The Committee finds substantial evidence that the human population living in the Great Lakes is exposed to appreciably more toxic chemical burdens than people in other similarly large regions of North America for which data is available. The difference appears to be largely due to the higher contaminant levels in food products from the Lakes and their basin.

FIGURE 1. AREAS OF CONCERN IN THE GREAT LAKES BASIN

SOURCE: Great Lakes Water Quality Board, 1985 Report on Great Lakes Water Quality (Kingston, Ontario: International Joint Commission, 1985), p. 36.

It is small wonder that all of the Great Lakes states post advisories warning the public -- and particularly nursing mothers -- against the consumption of certain fish. For example, the state of New York advises against consumption of any of the following species from Lake Ontario and the St. Lawrence and Niagara rivers: eel, channel catfish, lake trout, chinook salmon, coho salmon over 21 inches, rainbow trout over 25 inches, and brown trout over 18 inches. The contamination of Great Lakes fish is an especially distressing problem for a region whose sport-fishing has attracted tourists from all over the world.

Sources of the Problem

If toxic elements entered the Great Lakes solely through wastewater discharged from factories, EPA could eliminate the problem by gradually tightening industrial discharge permits until toxic pollutants were reduced to insignificant levels. However, the sources of contamination in the Great Lakes are considerably more varied. The NRC-RSC report documented earlier findings by the International Joint Commission and others that toxic wastes enter the lakes by numerous routes.

Airborne Pollutants

One of the most important routes is airborne contamination, estimated by the NRC-RSC study to be "the largest source of toxic organics and heavy metals in the upper Lakes: Lakes Superior, Michigan, and Huron." Indeed, atmospheric deposition is the only plausible explanation for the surprisingly high concentration of PCBs found in remote stretches of the lakes. An estimated 82 to 86 percent of the PCB pollution in Lake Superior falls from the sky. Table 3 presents data on airborne contaminants cited in the NRC-RSC study for each of the Great Lakes:

Table 3
Estimated Atmospheric Input of Several Organic Contaminants to the Great Lakes

Compound	Superior	Michigan	Huron	Erie	Ontario
	(metric tons per year)				
Total PCB	9.8	6.9	7.2	3.1	2.3
Dieldrin	0.5	0.4	0.6	0.2	0.1
Total PAH[1]	163.0	114.0	118.0	51.0	38.0
Total DDT	0.6	0.4	0.4	0.2	0.1
p,p[1]Methoxylchlor	8.3	5.9	6.1	2.6	1.9

[1]Polyaromated hydrocarbons

SOURCE: National Academy of Sciences, National Research Council, and the Royal Society of Canada, The Great Lakes Water Quality Agreement: An Evolving Instrument for Ecosystem Management, citing a 1981 study by Eisenreich et al.

Polluted Runoff

The runoff from urban and agricultural land is another major source of toxic pollutants. The International Joint Commission calculated that 11 million tons of sediment are washed into the Great Lakes every year. If carried from farmland, that sediment may be laced with pesticides. In 1972, an estimated 45 million pounds of pesticides was applied to cropland on the U.S. side of the Great Lakes basin.

Runoff from urban areas, which include city streets as well as industrial lots, is a major source of the heavy metals that characterize pollution in the Great Lakes, particularly in the nearshore areas of concern. The Canadian Great Lakes Toxic Chemicals Committee estimated in 1984 that urban runoff washed the following quantities of contaminants into the Great Lakes every year:

- 420 tons of zinc, lead, copper, nickel, and chromium;
- 8 tons of cobalt, mercury, arsenic selenium and cadmium;
- .077 tons of PCBs;
- .069 tons of chlorinated benzenes; and
- .034 tons of organochlorine pesticides.

Abandoned Dumpsites

Contaminated groundwater leaching into the lakes from abandoned waste disposal sites in heavily industrialized areas is another source of toxic pollutants. One hundred and sixty leaking landfills account for half of the 3,000 pounds of chemicals that enter the Niagara River every day. These chemicals are then swept into and dispersed throughout Lake Ontario by the Niagara, which provides 80 percent of the lake's water supply. The government of Ontario estimated that, until closed several years ago, a huge petrochemical plant dumped 750,000 litres of waste per day into Detroit River rock formations near the St. Clair River. Although the Ontario government shut down the deep wells years ago, the abandoned ones are a suspected source of the polluted groundwater discharging into the St. Clair River which feeds Lakes Erie and Ontario.

As many as 1,000 shallow toxic disposal sites are located in the Great Lakes basin. The eight U.S. states adjoining the Great Lakes contain 327 of the 858 sites included or proposed for inclusion on EPA's Superfund National Priority List (NPL) for cleanup. Many of these are located near industrial centers clustered around the shores of the lakes. Table 4 shows NPL sites in the Great Lakes states.

Table 4
Superfund Sites
Final and Proposed: January 1986

State	Number of Sites
Illinois	24
Indiana	26
Michigan	64
Minnesota	38
New York	59
Ohio	29
Pennsylvania	60
Wisconsin	27
Great Lakes Total	327
National Total	858

SOURCE: Environmental Protection Agency, National Priorities List (NPL) Facilities, W52-1216 (Washington, D.C., January 1986).

Embedded Sediments

Finally, toxic contaminants have become embedded in the sediment at certain areas where toxic discharges from a variety of sources over the years have been particularly heavy. The sediments, thought to be the source of the lip tumors found on bottom-feeding fish such as carp, may contribute toxic elements back into the water when disturbed by natural or man-made causes.

These "in-place" pollutants present problems similar to Superfund sites. First, the original generators may be impossible to identify or may have gone out of business long ago. Second, even when all current sources of pollution are identified and eliminated, contaminated sediments will remain.

However, only one of the 42 areas of concern, Waukegan Harbor in Illinois, has qualified for Superfund cleanup. Mark Van Putten, representing the National Wildlife Federation at the Mackinac Island conference, argued that such sites could qualify if the contamination of edible products -- such as fish -- could be considered in determining whether an abandoned waste site were eligible for Superfund cleanup.

Table 5 indicates the relative frequency with which each source of contamination has been linked by the Water Quality Board of the IJC with the areas of concern. The figures account only for the nearshore area contribution in each case. They do not account for atmospheric deposition, which is estimated on a lakes-wide basis. In addition, the table does not

measure the relative importance of each source. For example, the Niagara landfills leaking chemicals into the headwaters of Lake Ontario may have had a far greater impact on the Great Lakes ecosystem than urban runoff at sites further downstream. With these reservations in mind, the table does provide a good indication of which sources are particularly important at different locations in the Great Lakes basin.

Table 5
Sources of Pollution for Great Lakes Areas of Concern

Area of Concern	In-Place Pollutants	Industrial Point Sources	Municipal Point Sources	Urban Non-Point	Rural Non-Point	Combined Sewer Overflows	Waste Disposal Sites	Unknown
Peninsula Harbour, Ontario	X	X						
Jackfish Bay, Ontario	X	X						
Nipigon Bay, Ontario	X	X						
Thunder Bay, Ontario	X	X						
St. Louis River, MN	X							X
Torch Lake, MI	X	X						X
Deer Lake-Carp River, MI	X							
Manistique River, MI	X	X	X					
Menominee River, WI/MI	X							
Fox River/S. Green Bay, WI	X	X	X					
Sheboygan Harbor, WI	X							
Milwaukee Estuary	X	X	X	X	X	X		
Waukegan Harbor, IL	X							
Grand Calumet River/ Indiana Harbor Canal, IN	X	X	X	X		X		
Kalamazoo River, MI	X							
Muskegon Lake, MI								
White Lake, WI		X						
Saginaw River/Saginaw Bay, MI	X	X	X					
Collingwood Harbour, Ontario	X		X					X
Penetang Bay to Sturgeon Bay, Ontario			X	X	X			
Spanish River, Ontario	X	X						
Clinton River, MI	X	X	X	X	X	X		
Rouge River, MI	X	X	X	X	X	X		
Raisin River, MI	X	X	X	X	X	X		
Maumee River, OH	X	X	X	X	X	X		
Black River, OH	X	X	X	X	X	X	X	
Cuyahoga River, OH	X	X	X	X		X		
Ashtabula River & Harbor	X	X		X				
Wheatley Harbour, Ontario	X	X	X					X
Buffalo River, NY	X	X	X	X		X	X	
Eighteen Mile Creek, NY	X	X		X		X		
Rochester Embayment, NY	X	X	X	X		X		
Oswego River, NY	X	X	X	X		X	X	
Bay of Quinte, Ontario		X	X	X				
Port Hope, Ontario	X						X	
Toronto Waterfront, Ontario	X	X	X	X		X		
Hamilton Harbour, Ontario	X	X	X	X		X		
St. Mary's River, Ontario/MI	X	X	X	X		X		
St. Clair River, Ontario/MI	X	X	X			X		
Detroit River, Ontario/MI	X	X	X	X	X	X		X
Niagara River, Ontario/NY	X	X	X	X		X	X	
St. Lawrence River, Ontario/NY	X	X		X		X	X	

SOURCE: Great Lakes Water Quality Board, 1985 Report on Great Lakes Water Quality, Report to the International Joint Commission (Kingston, Ontario, International Joint Commission 1985), p. 4.

The Clean Water Act: Regulating the Industrial Dischargers

Responsibility for regulation and clean-up of pollution from the sources described in the previous section rests with various federal and/or state agencies. The Environmental Protection Agency's strategy thus far has centered on the regulation of industrial wastewater discharges through provisions of the Clean Water Act. To date, it is the most effective federal effort to solve the toxics problem in the Great Lakes basin.

Historical Overview

Federal officials seeking to regulate toxic discharges before passage of the 1972 Federal Water Pollution Control Act faced an uphill battle. First, EPA had to evaluate the quantity of toxic material in the water, and assess its impact on humans. Next, the agency had to quantify the contribution of each source to the contamination in the receiving waters. Finally, it had to prove that the effluent reduction would improve the quality of the receiving waters and produce corresponding benefits to public health. While those requirements appeared reasonable enough, they were impossible to meet, given uncertainty about the effects of toxic exposure to human health and the length of time before harmful effects may appear. To make matters worse, judges had almost total discretion over the fashioning of abatement orders for specific dischargers.

A hodgepodge of statutes gave the federal government limited authority to regulate polluters, and made enforcement action dependent on an exhaustive compilation of data. These weaknesses came to light in the famous case of Reserve Mining v. United States. The U.S. and the state of Minnesota together sought an injunction ordering the Reserve Mining Company to cease discharging its wastes into Lake Superior. The federal district court eventually ordered the company to stop discharging at once, even if it meant shutting down operations at the plant. District Court Judge Miles Lord, in an angrily worded opinion showing his frustration with Reserve Mining's previous failure to reduce pollution levels, brushed aside the company's claim of economic hardship and declared that:

> In essence, defendants are using the work force of Reserve's plant as hostages. The Court will have no part of this form of economic blackmail. . . . The defendants, who are daily endangering the lives of thousands of people, have the engineering and economic capacity to obviate the risk and choose not to do so in order to continue with the profitability of the present mode of operations. The Court cannot honor profit over human life, and has no choice but to abate the discharge.

The Eighth Circuit Court of Appeals overturned the injunction, on the grounds that:

> . . .an immediate injunction cannot be justified in striking a balance between unpredictable health effects and the clearly predictable social and economic consequences that would follow the plant closing.

The case was remanded for further consideration, but Miles Lord was eventually deprived of jurisdiction, on the grounds that he was biased against the defendants.

Congress put an end to the judicial dispute by restructuring the federal program through the Clean Water Act of 1977. The act required EPA to promulgate a national, uniform system of regulations that would require industry to install the "best available technology economically achievable" by a specified date. Deadlines for compliance were extended several times; for most major industries June 30, 1986, was selected. The best available technology (BAT) standards were to be applied (subject to limited exceptions) to all dischargers whether or not EPA could prove their beneficial impact on receiving water quality or on public health.

At first, EPA limited the use of technology-based standards to conventional pollutants (such as total suspended solids and fecal coliform), while regulating toxic discharges under Section 307 of the act. This section provided specific authority for such regulation, and a standard adequate for an ample margin of safety to protect the public health. However, EPA's rulemaking process under Section 307 moved very slowly. By January 1977, the agency had developed standards for only four toxic pollutants -- aldrin/dieldrin, DDT, endrin, and toxaphene (all four of which are found in the lakes). Part of the difficulty lay in the lengthy public hearings requirement of WPCA, which gave both industry and environmental groups the right to submit volumes of expert testimony challenging the scientific underpinning of the proposed regulation. At one point, EPA's confidence was so badly shaken that it withdrew the proposed toxic standards completely, asserting that it could not develop data adequate to support regulation.

Frustrated by the deadlines missed under Section 307, the Natural Resources Defense Council (NRDC) took EPA to court to force compliance with the rulemaking schedule. NRDC and EPA eventually negotiated a settlement. EPA agreed to list 65 specific pollutants as toxic, and to develop controls on an industry-by-industry basis, relying on the technology standards that hitherto had been applied only to conventional pollutants. The consent decree, which covered 21 industries responsible for an estimated 70 percent of industrial water pollution, was ratified by Congress in 1977. As a result, the best available technology standard and the timetable for applying it to specific manufacturing sectors became the centerpiece of the federal effort to force a reduction in toxic discharges.

Two factors make it difficult to evaluate the effect of the discharge permit system in the water quality of the lakes. First, EPA has concentrated its limited manpower on trying to cope with the strict deadlines established by the consent decree ratified by Congress. Consequently, any manufacturer or toxic substance not on the statutory list might have escaped the regulatory process. Second, while EPA has issued final regulations for all of the 21 industries on the list, the three-year

deadline for compliance has not lapsed for three categories -- organic chemicals, pesticides, and foundries (see Table 6). The last deadlines are set for June 30, 1988.

Table 6

COMPLIANCE DATES FOR PROMULGATED CATEGORICAL PRETREATMENT STANDARDS

INDUSTRIAL CATEGORY	COMPLIANCE DATE (month-day-year)
1. Timber Products	3-11-84
2. Electroplating	
o Non-integrated	4-27-84
o Integrated	6-30-84
3. Pulp, Paper, Paperboard	7- 1-84
4. Steam Electric	7- 1-84
5. Electrical Phase I	7- 1-84
6. Iron and Steel	7-10-85
7. Inorganic Chemical Phase I	8-12-85
8. Leather Tanning	11-25-85
9. Porcelain Enameling	11-25-85
10. Petroleum Refining	12- 1-85
11. Coil Coating Phase I	12- 1-85
12. Metal Finishing	2-15-86
13. Electrical Phase II	7-14-86
14. Copper Forming	8-15-86
15. Aluminum Forming	10-24-86
16. Pharmaceuticals	10-27-86
17. Coil Coating (canmaking)	11-17-86
18. Battery Manufacturing	3- 9-87
19. Nonferrous Metals Phase I	3 -9-87
20. Organic Chemicals	Compliance Required three years from date of promulgation
21. Pesticides	
22. Foundaries	
23. Inorganic Chemical II	
24. Nonferrous Metals - Forming	
25. Nonferrous Metals Phase II	

SOURCE: Great Lakes Water Quality Board, 1985 Report on Great Lakes Water Quality (Kingston, Ontario: International Joint Commission, 1985), p. 135.

Even with these difficulties, Clean Water Act standards no doubt already have prevented substantial quantities of toxic pollutants from entering the Great Lakes. Table 7 shows that a total of 369.5 million tons of toxic metals and organics were removed from waste streams in the eight Great Lakes states in 1983 (these figures include downstate areas as well as the Great Lakes basin). These states show a disproportionately high rate of removal for toxic metals because approximately 70 percent of the nation's primary steel, machine tool and metal-forming industries operate within their borders. Removal of toxic metal and organic substances will increase as compliance deadlines approach for foundries, metal finishers, and the organic chemical industry.

Economic Implications

One of the encouraging features of the discharge limitation program has been its surprisingly low cost, which has proved that large gains can be made in pollution control without sacrificing economic productivity. Table 8 shows capital and operating cost expenditures for water pollution control in the Great Lakes states for 1979 and 1983 as compiled by the Bureau of the Census. In keeping with the national trend, capital costs declined in the Great Lakes basin while operating expenses of maintaining the new pollution-control equipment increased. Expenditures in the Great Lakes states accounted for approximately 40 percent of the national total, a figure proportional to the size of the region's manufacturing base. These data show that manufacturers in the Great Lakes do not bear disproportionately high pollution-control costs. The Bureau of the Census data shown in Table 9 compare expenditures by industrial sector in the Great Lakes with those for the nation as a whole.

A more up-to-date perspective is provided in EPA studies estimating the impact of the BAT standard on selected industries. Table 10 presents EPA's evaluation of how its BAT regulations will affect certain industries as measured by several economic variables. While investments in pollution control are large, especially for the organic chemical*, iron and steel, and electroplating industries, projected costs are not expected to rise above 4.5 percent of sales for any industrial sector. These estimates generally reflect worst-case scenarios, with figures representing the costs for the least economical plant in each category. Potential plant closings and job-loss projections also are minimal. The electroplating industry would be one of the hardest hit, with up to 30 plant closings and a possible loss of 980 jobs. However, the compliance deadline was extended for electroplaters since the regulations were issued, which may reduce costs and avoid more plant closings.

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*EPA has characterized three options for the chemical industry's effluent guidelines. Option I would have the lowest impact, option II is in the middle-range, and option III would be the most expensive. The last five columns in Table 10 reflect only the second option. It appears to be closest to the regulations that EPA is likely to adopt. If option III is realized, capital costs could rise to $1.477 billion, operating costs to $677 million; employment losses could exceed 11,000.

Table 7
Quantity of Toxic Pollutants Removed, 1983

Region and State	Toxic Metals	Toxic Organics
	(millions of metric tons)	
Illinois	30.6	16.5
Indiana	46.2	6.3
Michigan	92.1	173.6
Minnesota	3.2	3.6
New York	30.2	37.4
Ohio	47.2	103.1
Pennsylvania	83.8	140.6
Wisconsin	6.2	1.5
Great Lakes Total	369.5	482.6
National Total	852.4	1240.5

SOURCE: Department of Commerce, Bureau of the Census, Current Industrial Reports: Pollution Abatement Costs and Expenditures 1983 (Washington, D.C., 1985).

Table 8
Water Pollution Control Expenditures, 1979-1983

Region and State	Capital Expenditures		Operating Expenditures	
	1979	1983	1979	1983
	(in millions of dollars)		(in millions of dollars)	
Illinois	49.3	26.3	166.1	184.8
Indiana	74.0	20.0	154.5	197.2
Michigan	77.8	43.8	157.8	206.5
Minnesota	29.6	12.2	40.0	66.7
New York	60.6	40.5	140.1	172.3
Ohio	54.9	38.1	196.9	241.5
Pennsylvania	109.7	47.8	172.5	215.0
Wisconsin	17.2	8.4	89.5	110.3
Great Lakes Total	476.1	237.1	1,117.4	1,404.3
National Total	1,245.7	819.0	3,015.6	3,943.2

SOURCE: Department of Commerce, Bureau of the Census, Current Industrial Reports: Pollution Abatement Costs and Expenditures 1983 (Washington, D.C., 1985).

Table 9
Water Pollution Control Operating Costs, 1983
(in millions of dollars)

Industry	IL	IN	MI	MN	NY	OH	PA	WI	Total	National Total
Food and kindred products	12.1	3.3	6.3	5.7	8.3	6.3	11.4	10.3	63.7	402.3
Lumber and wood products	0.2	0.1	2.5	N/A	--	1.4	N/A	0.1	4.3	27.8
Furniture and fixtures	0.9	0.2	0.2	--	--	--	0.5	N/A	1.8	11.2
Paper and allied products	1.4	1.1	17.7	10.8	17.4	13.9	17.1	55.4	134.8	508.9
Printing and publishing	0.8	2.6	0.8	N/A	0.2	0.3	1.4	0.2	6.3	21.8
Chemicals and allied products	35.7	38.2	33.4	0.1	36.8	33.2	22.4	2.5	202.3	1,106.0
Petroleum and coal products	20.2	N/A	7.0	N/A	N/A	7.8	17.5	N/A	52.5	552.3
Rubber and miscellaneous plastic products	1.1	N/A	0.4	--	0.3	2.5	0.4	0.5	5.2	52.8
Stove, clay and glass products	0.5	N/A	3.1	0.7	1.7	5.4	3.7	0.7	15.8	55.8
Primary metal products	28.4	94.5	1.8	0.8	12.2	68.5	76.3	1.8	300.3	454.6
Machinery, except electrical	16.1	2.3	12.5	0.8	3.7	8.8	5.3	1.4	50.9	137.8
Electric and electronic equipment	11.2	1.5	4.7	5.1	8.6	8.1	2.1	1.9	43.2	105.0
Transportation equipment	5.6	7.1	0.4	0.6	20.4	4.6	10.9	0.8	50.4	142.0
Instruments and related products	7.7	8.4	48.9	N/A	7.7	25.8	6.8	1.8	105.1	224.2
Textile mill products	1.0	0.6	--	N/A	19.5	0.4	N/A	N/A	21.5	53.9
Leather and leather products	--	--	N/A	--	--	0.1	2.2	--	2.3	54.5
Miscellaneous manufacturing	--	--	1.8	--	0.6	--	--	0.1	2.5	11.6
	0.1	--	--	--	N/A	--	N/A	N/A	0.1	13.0
Total	142.9	171.6	149.9	35.0	138.1	185.1	180.5	78.0	1,404.3	3,943.2

SOURCE: Department of Commerce, Bureau of the Census, Current Industrial Reports: Pollution Abatement Costs and Expenditures 1983, (Washington, D.C., 1985).

Table 10
Cost of Clean Water Act Regulation for Selected Industries

Industry	Federal Register Publication Date	Pretreatment Costs (in millions)		Total Costs (in millions)		Percent Increase Production Costs	Plant Closing	Potential Job Loss
		Capital	Operating	Capital	Operating			
Battery Manufacturing (cadmium, lead and zinc)	3/9/82	8.2	4.4	9.3	5.0	0.04 to 0.3 (Price Increase)	None	None
Coil Coating (Can-making subcategory)	11/17/83	21.3	17.1	22.0	18.0	0.0	1	26
Electric and Electronic Components (Cathode ray tube and luminescent materials)	12/14/83	6.5	3.4	6.5	3.4	Not Given	None	None
Electroplating/Metal Finishing (Captive integrated shops)	7/15/83	827.0	274.0	N/A	N/A	0.03 to 2.0	30	980
Inorganic Chemicals (Phase I)	6/29/84	9.9	7.6	28.9	26.2	--	0	60
Inorganic Chemicals (Phase II)	8/22/84	1.1	0.5	5.9	2.8	0.01 to 2.0	0	0
Iron and Steel Manufacturing	5/27/82	143.1	22.9 to 23.8	2497.6 to 2644.9	735.4 to 794.0	0.6 to 1.2	No long-term impact	2,000 short-term; no long-term impact
Metal Molding and Casting	10/30/85	46.7	21.5	90.4	41.2	1.0 to 4.5		162
Non-ferrous Metals Forming	8/23/85	8.8	4.6	14.3	8.9	0.2 (Average)	2	56
Organic Chemicals	7/17/85	189 to 304	135 to 166	901[1]	556[1]	Not Given	34[1]	5,561[1]
Pesticides	10/4/85	61.7	35.7	130.7	70.9	0.62 to 1.3	25	12
Plastics Molding and Forming	12/17/84	0.0	0.0	7.0	4.5	Less than 0.3	0	25
Porcelain Enameling	11/24/82	18.7	9.9	25.4	13.6	0.1 to 2.6	2	90
Pulp, Paper and Paperboard (New sources only)	11/18/82	--	--	27.7	9.6	0.0 to 3.2	--	2,000 in foregone new employment

[1]Reflects option II of EPA's proposed regulation for the organic chemical industry.
SOURCE: Federal Register, dates as stated.

Comparing the U.S. and Canadian Programs

The Water Quality Board of the International Joint Commission maintains records of compliance with the individual discharge permits pursuant to EPA standards. In 1983, 87 of 483 U.S. manufacturers in the Great Lakes basin exceeded their permit conditions, with New York recording 52 of its 147 facilities in violation. While the U.S. compliance rate is less than desirable, it compares favorably with the Canadian record, where the Water Quality Board tallied 43 violations among the 99 permits granted.

Unlike the U.S. system of uniform national standards, Canadian pollution control permits are negotiated individually. Canadian scientists privately admit that enforcement of controls over industrial dischargers leave much to be desired. This contention would no doubt be disputed by Ron Denning of the Lambton Industrial Society, a Canadian manufacturers association. He advised the U.S. delegation during a briefing at the Canadian Centre for Inland Waters (CCIW) in Toronto that Canadian industry generally performed better than the minimum legal requirements. Manufacturers in the Lambton area, he argued, had taken an aggressive approach to pollution control; he cited the Lambton Industrial Society's voluntary 18 percent reduction in phenolic wastes over the past decade.

Despite frustrations and missed deadlines, both the United States and Canada have made progress in establishing minimum technological standards for water pollution control. However, environmentalists support further restrictions on issuance of industrial discharge permits where water quality remains poor despite manufacturers' application of the best available technology. As envisioned by Jim Banks, formerly of the Natural Resources Defense Council, these water-quality based standards would supplement technology-based controls:

> Once BAT is in place, EPA needs to determine where technology controls have not been sufficient to protect water quality and human health from toxics hazards, and then to develop controls "beyond BAT" on a site-specific basis. These toxic hotspot strategies could be built on water quality standards. . . .

The Clean Water Act reauthorization bill approved by the 99th Congress requires additional regulation of those areas where water quality remains substandard even after all industrial dischargers applied the best available technology to their plants. While the president vetoed the Clean Water Act on November 6, 1986, it is expected to pass intact early in the 100th Congress. Should the president veto the bill again, Congress probably will override the veto.

Needed: An Ecosystem Approach

Most of the 42 areas of concern identified by IJC would be subject to these new legislative "toxic hotspot" provisions. However, the IJC's preliminary analysis of sources of contamination at those hotspots identified culprits other than factories -- abandoned dumpsites, urban and rural runoff, and in-place pollutants. The amended Clean Water Act requires that industrial discharge permits be tailored to reflect the contribution these "non-point" sources make to pollution, but does not provide for any direct regulation. Because many kinds of toxic contaminants enter the Great Lakes basin from a wide variety of sources, the U.S. will have to move beyond the present control program, which is based almost entirely on the regulation of industrial dischargers. An "ecosystem approach" -- the coordinated regulation of pollutants from all sources -- is the most promising solution.

The Canada-U.S. Water Quality Agreement

The ecosystem approach is, in fact, a cornerstone of the Canada-U.S. Great Lakes Water Quality Agreement. The International Joint Commission, represented at the Mackinac Island conference by U.S. Commissioner Robert McEwen, first publicized the need for an ecosystem-based cleanup strategy. The IJC's landmark 1981 report demonstrated the importance of proper farming practices to Great Lakes water quality. The 1985 joint National Research Council and Royal Society of Canada report emphasized the need for ecosystem management through the Water Quality Agreement:

> The committee finds that improving and sustaining Great Lakes water quality is an objective that is intimately related to how the linkages within the basin ecosystem are viewed within and, to an important extent, outside the Great Lakes basin.

The U.S. government has considerable statutory authority with which to put in place an ecosystem-based program. While the control of non-point runoff probably will remain in state hands, EPA has broad power to regulate hazardous air pollutants, to cleanup abandoned hazardous dumps, and to remove contaminated sediment from Great Lakes harbors.

U.S. Great Lakes Programs: A History of Neglect

So far, the ecosystem approach has remained a paper concept. The lack of resources or organizational structure to implement the Great Lakes Water Quality Agreement has hindered any real progress. A 1982 U.S. General Accounting Office report found that Great Lakes programs -- divided among 14 federal agencies and eight states -- were fragmented and inadequately funded. While funding prospects have improved slightly in recent years, the Reagan administration (as did the Carter administration) has continued to cut back on Great Lakes programs. Table 11 compares fiscal 1986 spending for Great Lakes management programs with the fiscal 1987 request.

While Congress has managed to provide level funding for Great Lakes programs over the past several years, coordination among the various agencies has been on an ad hoc basis. Agencies have made efforts periodically to overcome these institutional constraints. For example, the Great Lakes National Program Office (GLNPO), which has general responsibility for implementing the Water Quality Agreement, participated with the Soil Conservation Service in a successful series of conservation-tillage demonstration projects designed to reduce non-point runoff from farms in the Ohio River valley. More recently, GLNPO successfully negotiated an agreement with Wisconsin, Illinois, Indiana, and Michigan to issue uniform health advisories for the consumption of Lake Michigan fish.

Table 11
Federal Spending for Great Lakes Management Programs
(in millions of dollars)

Agency	Fiscal 1986 Expenditures	Fiscal 1987 Request
Environmental Protection Agency		
Great Lakes National Program Office	4.8	4.8
Great Lakes Laboratory	2.5	0.9
Department of Commerce/NOAA		
Great Lakes Environmental Research Laboratory	3.6	3.0
Sea Grants[1]	6.2	0
Coastal Zone Management[2]	5.5	0
Department of the Interior		
Great Lakes Fisheries Laboratory	3.2	3.4
TOTAL	25.6	12.1

[1]Great Lakes states with Sea Grant colleges include Illinois and Indiana (shared program), Michigan, Minnesota, New York, Ohio, and Wisconsin.
[2]Great Lakes states receiving Coastal Zone Management Grants include Michigan, New York, Pennsylvania, and Wisconsin.

These efforts have been piecemeal to date, however, as uncertainty about budgets and program jurisdiction continue to plague water-quality management for the Great Lakes. For example, a Toxics Monitoring and Surveillance Network, which is explicitly required by the agreement, has never been established. Such a network would help scientists and regulators understand the source and movements of toxic compounds in the Great Lakes basin. This knowledge, in turn, would provide information on which to base individual pollution-control decisions.

The U.S. neglect of the Water Quality Agreement stands in stark contrast to the progress made in Canada. Jeremy Kingham, director of the Canadian Centre for Inland Waters, explained to the visiting U.S. delegation that Environment Canada invests nearly $25 million annually in activities specifically dedicated to the agreement. While the U.S. expenditures in fiscal 1986 (and the likely budget for fiscal 1987) approximate that amount, the U.S. side of the Great Lakes basin has four times the population and nearly five times the industrial dischargers. In addition, only one U.S. agency's budget, the GLNPO's annual $5 million, is dedicated specifically to fulfilling the agreement's objectives.

The Kasten-Nowak Amendment: A Commitment from Congress

Fortunately, the Clean Water Act reauthorization bill includes provisions drafted by Senator Robert Kasten (R-WI) and Representative Henry J. Nowak (D-NY) that attempt to remedy the problem. Their amendment provides $55 million over five years to strengthen GLNPO and to add a Great Lakes research program to the National Oceanic and Atmospheric Administration (NOAA). It represents an additional commitment of $35 million over current resources devoted to the agreement's goals, and provides multi-year funding to give EPA time to build a strong program.

The amendment provides explicit congressional recognition of the Great Lakes Water Quality Agreement for the first time. It also designates GLNPO as the lead agency responsible for U.S. compliance with the agreement. EPA would be required to report to Congress annually regarding progress toward meeting the agreement's objectives.

EPA also would have to submit a multi-agency budget detailing the resources to be dedicated to the agreement's ecosystem approach to Great Lakes water quality management. This requirement is especially significant. The agreement must have solid budget support if its goals are to be realized. Requiring multi-agency budgeting toward a common objective is the first step in building the institutional networks that the NRC-RSC report identifies as critical to effective ecosystem management. It also provides a way for the Congress and other interested groups to evaluate the administration's willingness or ability to match the resources committed to the agreement by Canada.

The amendment directs GLNPO to establish, once and for all, a comprehensive Toxics Monitoring and Surveillance Network for the lakes. The monitoring system would use a "mass balance" approach, which involves calculating pollutant loadings over the vast surface of the lakes and deducing the causes from the effects. The information gathered must be as complete as possible for the network to be effective in reducing pollution levels. The amendment recognizes the need to sample the deep open waters of the lakes consistently and often, as well as the nearshore areas of concern. The monitoring network also should include the sampling of sediments and acquatic life for signs of contamination.

The amendment requires NOAA to establish and maintain exchanges of research and to develop a comprehensive environmental data base for the Great Lakes. The U.S. does not maintain a facility similar to the Canadian Centre for Inland Waters, where the results of research throughout the lakes can be gathered, analyzed, and used to prompt further investigations.

The amendment also requires EPA to begin the task of cleaning up contaminated sediments at the Great Lakes areas of concern identified by the International Joint Commission. Five sites are mentioned specifically for demonstration cleanup to ensure that the program gets off the drawing boards, and to give Congress a basis for evaluating the agency's progress. The five sites are Sheboygan Harbor, Wisconsin (site of the studies of infants weaned by mothers consuming PCB-contaminated fish cited earlier); Saginaw Harbor, Michigan; Grand Calumet Harbor, Indiana; Ashtabula River, Ohio; and Buffalo River, New York. Finally, the Kasten-Nowak amendment directs GLNPO, in cooperation with federal and state agencies, to develop a management strategy to meet the goals of the Water Quality Agreement.

EPA already has shown signs of responding to criticism of its neglect of the Great Lakes and the Water Quality Agreement. GLNPO has outlined a five-year cleanup program for the lakes based on a mass balance approach to pollution control. It would calculate the total amount of toxic wastes deposited in the lakes from all sources, setting a target for reducing the total contaminant load to a specified level and allocating the reductions among the various sources according to their estimated contributions. Peter Wise, director of GLNPO, briefed the Canadian and U.S. delegations on this approach during the Mackinac Island conference. While the proposal is ambitious, it represents the only rational approach to pollution control for a huge body of water receiving toxic pollutants from so many different sources.

The Great Lakes: The Years Ahead

The Canada-U.S. Great Lakes Water Quality Agreement, scheduled for renewal in 1986, offers a comprehensive framework for the protection of the Great Lakes environment. The Kasten-Nowak amendment to the Clean Water Act grants EPA the resources and, for the first time, a clear mandate to make the ambitious goals of the agreement a reality. Unfortunately, both the Carter and Reagan administrations, when they have acknowledged the agreement at all, have treated it as a vague statement of principles with no practical application to environmental decision-making. Budget requests in both administrations cut Great Lakes programs repeatedly. Although these funds always are restored by Congress, the yearly war has taken its toll.

For example, EPA's Large Lakes Laboratory at Grosse Isle, Michigan, is operating with a slightly smaller budget than it had six years ago, despite the fact that the cost of replacing and maintaining laboratory equipment has risen much faster than the general inflation rate. The 1982 GAO report contained a stinging critique of EPA's Great Lakes record; the same sentiments are expressed, although in milder terms, by the 1985 National Research Council-Royal Society of Canada report. U.S. federal indifference is a sensitive subject to Canadians, who take the Water Quality Agreement seriously and dedicate a much larger budget -- in actual dollars and on a per capita basis -- to the achievement of its objectives.

Pollution control in the Great Lakes in the future is likely to be concerned increasingly with the regulation of such non-point sources as airborne contamination, runoff, and toxic sediments. Trying to relate the contribution that each of these sources makes to control measures will be a Herculean task when compared to the more traditional monitoring of outfalls from sewage treatment plants or factories. It will require an ever more sophisticated Great Lakes research network that simply cannot be built on a foundation of neglect and shrinking resources.

Fortunately, EPA Administrator Lee Thomas has shown interest in the Great Lakes National Program Office, which has begun assuming a more visible role. Congressional oversight of Great Lakes water quality issues also has increased. In July 1986, the House Public Works Subcommittee on Oversight held the first hearings on U.S. implementation of the Water Quality Agreement. Mr. Thomas publicly affirmed his commitment to the agreement objectives, and to development by EPA of an integrated toxics control strategy for the Great Lakes basin.

One of the more important requirements of the Kasten-Nowak amendment is that EPA develop a budget for the Great Lakes cleanup required by the agreement, and report to Congress on how the money is being spent. Congress will need "dollars and cents" estimates of the costs of various alternatives if it is to have any role in the development of a Great Lakes environmental policy. If these are not forthcoming, action on such

intractable issues as contaminated harbor sediments will be postponed continually and the agreement itself will be reduced from an action plan to a collection of platitudes. GLNPO has outlined a comprehensive cleanup program for the lakes; it needs only financial support to make it effective. A centerpiece of GLNPO's proposal is the development of remedial action plans for toxic-saturated sediments at the 42 areas of concern. The cleanup at just one of those sites, Waukegan Harbor, Illinois, is estimated to cost $22 million. With 40 similar sites, the total cost of the harbor sediment cleanup program could exceed $800 million.

The Waukegan cleanup, however, is probably more expensive than most due to the extremely hazardous nature of PCBs embedded in the harbor bottom. Nevertheless, it is not too early to focus on the kinds of investment that an effective Great Lakes cleanup program would require, so that both EPA and Congress can set priorities based on the limited resources available. This recommendation is not a new one, as it simply echoes the conclusions of reports from the General Accounting Office and the National Research Council.

While serious effort to develop a budget for the Great Lakes is an absolute necessity if Congress is to make the best use of what federal resources are available, the fact remains that the resources are limited. EPA has fared well under the Gramm-Rudman-Hollings balanced budget law when compared to other agencies. But its overall budget, with the important exception of Superfund, will not increase any faster than the general inflation rate in the years ahead. Where can the resources for an investment in Great Lakes water quality be found in an era of limited federal spending?

One possibility is to charge an annual fee for the discharge permits that allow both municipal sewage treatment plants and factories to pour hundreds of thousands of gallons of toxic waste into the lakes. Currently, permit-holders are required to measure and report on the quality of the actual discharge itself, but are generally not responsible for testing the receiving waters for the presence of toxic contaminants. These monitoring costs are always high, and even more expensive and complex in the Great Lakes, where toxic pollutants may be carried great distances by the wind and tides.

The revenues from permit fees could be used to develop the kind of sophisticated monitoring network that the Water Quality Agreement mandates. This scheme would place the burden of tracking the movement of toxic waste through the lakes ecosystem on the parties responsible for this generation. The fees could be set at relatively low rates and still raise sufficient revenue. The International Joint Commission's 1985 report estimated that 271 factories discharged wastewater within the eight states surrounding the Great Lakes in that year. A fee structure that averaged $10,000 per facility (with individual rates adjusted according to the size of the discharger) could raise an additional $2.7 million for a basin-wide

monitoring program.* Because more sophisticated monitoring would further improve the understanding of the role of non-point sources in toxic pollution, the fee system might actually win the suppport of industries that otherwise will bear the brunt of further regulation.

While the rest of the Great Lakes budget will remain static, the Superfund program for the cleanup of abandoned dump sites will grow quickly in the years ahead. The Great Lakes are lined with these leaking landfills. EPA should continue to give priority to sites on the Niagara River identified by the IJC as major sources of toxic contamination. EPA also should consider reforming Superfund criteria for site selection to include areas containing highly contaminated sediments. These toxic hotspots have the same genesis as the hazardous waste sites along the shoreline: years of cheap disposal practices made worse by ignorance or neglect, with the responsible parties either unknown, or financially unable or unwilling to accept the responsibility for cleanup.

While Congress has struggled to find solutions to the sulfur and nitrogen oxide emission thought to cause acid rain in the Northeast, other hazardous air pollutants create a far more serious problem in the Great Lakes region. These "smokestack" sources of water pollution in may increase as incineration becomes a preferred waste-management option, and as wastes dredged from abandoned Superfund sites are destroyed through combustion. EPA's progress in regulating hazardous air pollutants is excrutiatingly slow, and has drawn the criticism of the General Accounting Office. If Congress decides to consider amendments to the Clean Air Act during the 100th Congress, there will be an opportunity to strengthen the hazardous air pollution control program.

Clearly, the states will have to accept a larger share of responsibility for the protection of the Great Lakes. The intractable problem of non-point pollution requires some regulation of land use in the Great Lakes basin, a function long considered the province of state and local governments. Current efforts in Maryland and Virginia to control development along the Chesapeake Bay might provide useful information for the establishment of similar programs for the Great Lakes.

It is essential for the states and Canadian provinces surrounding the Lakes to work together, because pollution does not respect political boundaries. An encouraging trend toward greater coordination began in March 1985; the four states surrounding Lake Michigan (Illinois, Indiana, Michigan, and Wisconsin) agreed to standardize the measurement of toxic contaminants in Great Lakes fish. The resulting data will be shared with EPA's GLNPO (which helped negotiate the agreement), and used to develop uniform health advisories regarding the consumption of Great Lakes fish.

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*Less money would be raised if the fees were limited to those industries discharging into the Great Lakes basin.

In May 1986, the Great Lakes governors signed a Toxics Agreement setting forth a comprehensive set of principles to unify the management of toxic pollution in each state. The agreement provides for greater information sharing among the jurisdictions, and for the coordination and improvement of health registries that measure the incidence of cancer among the population of the Great Lakes basin and evaluate its sources. The Great Lakes state environmental administrators probably will meet more frequently as a result of the Toxics Agreement. Negotiating a basin-wide plan to control toxic pollution as recommended by the International Joint Commission ought to be near the top of their agenda.

Another hopeful sign is the emergence of new organizations dedicated to the improvement of the Great Lakes environment. Among these are the state of Michigan's Great Lakes Office, which played a key role in negotiation of the Toxics Agreement; the Center for the Great Lakes, whose sponsorship of the Mackinac Island conference was part of its continuing effort to promote consciousness of the Water Quality Agreement in Washington and throughout the region; and Great Lakes United, an umbrella group of environmental organizations that recently concluded a series of field hearings to focus attention on the toxic-laden "areas of concern" identified by the IJC. These organizations, together with long-established groups such as the Great Lakes Commission and the Midwest Chapter of the Sierra Club, give the people of the Great Lakes states a stronger voice in the protection of the environment they live in.

In the final analysis, the only sure way to keep toxic wastes from spoiling the lakes is to reduce the huge volume generated as a by-product of manufacturing. The emphasis to date has centered on the proper management of wastes once they are produced. Thus, strict controls on water discharges may result in the separation of toxic materials for burial in a landfill, where they may seep into ground or surface water, or for combustion in incinerators, which may create contaminants carried to the lakes by rain or wind.

However, this shuffling of waste from air to water to land management according to various regulatory timetables could be reduced if companies made fewer waste-intensive products. Recently, a major report by the U.S. Office of Technology Assessment pointed out both the environmental risks and the enormous administrative costs associated with monitoring wastes already generated to ensure proper neutralization or secure disposal. Other recent studies, including reports by Inform, Inc. and the Institute for Local Self-Reliance, have shown that changes in engineering practices and the substitution of less hazardous raw materials can cut waste generation while actually saving money in waste management or materials costs. According to the Department of Commerce, U.S. industries spent $101 million on actual process changes to reduce waste in 1983, compared to $718 million to treat wastes already created. These figures must be treated with caution, because they reflect only one year's data. Nevertheless, they do suggest that the current regulatory structure encourages management of pollution, rather than its reduction.

The Toxics Agreement signed by the Great Lakes governors recognizes this problem and cites waste reduction as one of its goals. Finding ways to encourage the economical reduction of hazardous waste should be a priority for decision-makers at the federal and state level in the years ahead. This effort is particularly relevant to the Great Lakes, where large volumes of toxic pollution from many sources strain the resources of even the most sophisticated form of ecosystem management.

The Great Lakes basin is the center of one of the world's greatest industrial civilizations. What better place to prove that living with toxic pollution need not be the price we pay for material progress?

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